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SERUM d-β-HYDROXYBUTYRATE AND UREA NITROGEN AS INDICATORS OF BEEF COW NUTRITIONAL STATUS

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Summary

Mature Simmental x Angus crossbred cows were fed differing levels of nutrition before and after calving (mid-March to early May) to determine if blood serum levels of d-β-hydroxybutyrate (BHB) and urea nitrogen (SUN) could be used as indicators of nutritional status. Visual condition scores and condition score change were used as subjective appraisals of cow nutritional status. BHB levels prior to calving were elevated for cows close to calving and those carrying male fetuses. SUN levels prior to calving were higher for thin cows that were losing body condition. If on a low plane of nutrition after calving, BHB values were higher for fleshier cows in May. No differences for either blood metabolite in May were observed for cows fed higher levels of nutrition after calving. A combination of the two metabolites indicated general changes in nutritional status of beef cows. Large variation among cows of similar condition made these metabolites inconsistent in evaluating small differences in nutritional status.

(Key Words: Beef Cow, Nutrition, Condition Score, Blood Metabolites.)

Introduction

Past studies have suggested that the ketone body d-β-hydroxybutyrate (BHB), which is derived from fatty acids and used as an energy source, may be a useful indicator of cow nutritional status. Cows fed diets lower in energy content than required to maintain body weight would start to utilize fat reserves for energy which may be monitored by BHB. Thin animals with little or no stored fat deposits start to utilize their own muscle tissues for energy which possibly could be monitored by serum urea nitrogen (SUN). The objective of this study was to evaluate BHB and SUN as a research tool for indicating beef cow nutritional status.

Materials and Methods

Data were collected over 2 years from 129 mature, Simmental x Angus cows wintered at the SDSU Range and Livestock Research Station near Philip that calved from mid-March to mid-May. In early December of each year, cows were allotted by age and previous calving date to a high or low early winter nutritional treatment. All cows were fed and managed as one group from mid-February until calving. Within 1 week after calving, cows were reallotted by calving date, calf sex, cow age and early winter treatment to a high or low late winter treatment which lasted until "turnout" onto summer pastures in early May. Nutritional treatments were designed to create a wide range of cow condition scores in mid-March and early May (Tables 1 and 2). Visual cow body condition scores (CS 1-9, 1 = extremely emaciated) were assigned in February, March and May using the average score of two individuals.

In mid-March and early May blood samples were collected from cows after feed and water were withheld for 18 hours. Clotted blood was centrifuged and separated serum was frozen for later colorimetric determinations of serum urea nitrogen (SUN) and d-β-hydroxybutyrate (BHB).

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Results and Discussion

Early winter nutritional treatments did not affect cow BHB levels prior to calving in March (Tables 1 and 2). SUN concentrations in March were elevated in cows on low early winter treatment during the second year when cows averaged one condition score less than cows on high treatment.

Since diet may affect blood metabolite levels, the only valid treatment comparisons in May were the effects of early winter treatment on cows on the same late winter treatment. Early winter nutrition did not affect blood metabolites if cows received the high nutritional treatment after calving. If cows were fed the low nutritional treatment after calving (which produced more severe weight loss), BHB and SUN in combination indicated greater muscle breakdown for cows that were thinner at calving due to low early winter nutrition and greater fat breakdown for fleshier cows due to higher early winter nutrition.

TABLE 1. EFFECT OF 1986 EARLY AND LATE WINTER TREATMENTS ON COW PERFORMANCE AND BLOOD METABOLITE LEVELS

Early winter treatment (12/9/85-2/7/86)	High		Low	
Late winter treatment (calving-5/9/86)	High	Low	High	Low
No. cows	25	23	22	24
Initial wt, lb, 12/9/85	1032	1049	1014	1014
Total winter weight change 12/9/85-5/9/86, lb	-121^{a}	-165^{bc}	-143^{ab}	-194^{c}
Condition score:				
2/7/86	5.6^{a}	5.5^{a}	4.8^{b}	4.3^{c}
3/7/86	5.5^{a}	5.1^{ab}	4.9^{bc}	4.6^{c}
5/9/86	4.5^{a}	3.6^{b}	4.1^{a}	2.9^{c}
d-β-hydroxybutyrate, mg/dl				
3/7/86	4.5$_{a}$	4.0$_{b}$	4.7$_{a}$	4.4
5/9/86	2.8^{a}	2.2^{b}	2.8^{a}	1.6^{c}
Serum urea nitrogen, mg/dl				
3/7/86	11.9	12.0$_{b}$	12.1$_{a}$	12.8$_{b}$
5/9/86	16.9^{a}	13.1^{b}	16.2^{a}	14.2^{b}

^{a,b,c} $P<.05$.

TABLE 2. EFFECT OF 1987 EARLY AND LATE WINTER TREATMENTS ON COW PERFORMANCE AND BLOOD METABOLITE LEVELS

Early winter treatment (12/5/86-2/13/86)	High		Low	
Late winter treatment (calving-5/8/86)	High	Low	High	Low
No. cows	25	24	21	24
Initial wt, lb, 12/5/85	1135	1138	1135	1118
Total winter weight change 12/5/85-5/8/86, lb	-174[a]	-254[b]	-218[c]	-295[d]
Condition score:				
2/13/87	6.3[a]	6.4[a]	5.2[b]	5.1[b]
3/6/87	6.2[a]	6.0[a]	5.3[b]	5.2[b]
5/8/87	4.8[a]	3.6[b]	4.5[a]	2.5[c]
d-β-hydroxybutyrate, mg/dl				
3/6/87	3.8	4.9	5.2	5.7
5/8/87	3.1[a]	4.9[b]	2.6[a]	3.6[a]
Serum urea nitrogen, mg/dl				
3/6/86	9.3[a]	9.2[a]	10.6[ab]	11.5[b]
5/8/87	16.6[ab]	15.4[a]	17.8[b]	17.7[b]

[a,b,c] $P<.05$.

Sex and day of gestation influenced cow BHB levels in March (Table 3). Cows with male fetuses (average birth weight = 93 lb) had higher BHB concentrations than cows with female fetuses (average birth weight = 87 lb). In addition, cows closer to their calving date had higher BHB levels in March. BHB levels decreased .04 mg/dl for each day further away a cow was from calving ($P<.01$). SUN levels were not affected by calf sex or day of gestation.

TABLE 3. EFFECT OF SEX OF FETUS ON BHB AND SUN LEVELS IN MARCH

Sex of fetus	Male	Female
No. cows	105	108
BHB, mg/dl	4.8[a]	4.1[b]
SUN, mg/dl	11.7	11.3

[a] $P<.05$.

When cow condition score in March and condition score change from February until March were used as an indication of cow nutritional status, BHB levels in March were similar for all condition scores (Table 4). SUN in March was higher for cows in condition score ≤ 4 than cows in condition score ≥ 6. Thin cows in condition score 4 or less that were losing body condition had the highest SUN levels, possibly indicating that thin cows no longer had adequate fat stores and were using muscle tissue as an energy source.

TABLE 4. EFFECT OF COW CONDITION SCORE IN MARCH AND CONDITION SCORE CHANGE ON BHB AND SUN LEVELS IN MARCH

	March condition score								
	3,4			5			6,7,8		
	Condition score change (February-March)								
	-1	0	1	-1	0	1	-1	0	1
No. cows	8	31	6	12	78	11	8	53	6
BHB, mg/dl	3.9	4.4_{bc}	4.3_{ab}	4.4_{bc}	4.8_{bc}	5.3_{ab}	5.8_{c}	3.9_{bc}	3.0_{bc}
SUN, mg/dl	14.3^{a}	11.0^{bc}	12.7^{ab}	11.3^{bc}	11.1^{bc}	12.8^{ab}	8.9^{c}	11.1^{bc}	9.7^{bc}

^{a,b,c} $P<.05$.

Blood metabolite levels by condition score in May were analyzed separately for each late winter treatment as dietary nitrogen intake has been shown to influence SUN. Nearly all cows were losing body condition after calving until blood samples were collected in May. Cows on low postcalving nutrition with lower condition scores in May were metabolizing less fat as indicated by lower BHB levels (Table 5). No differences in May BHB or SUN values were observed among condition score groups for cows fed the high level of late winter nutrition (Table 6).

TABLE 5. EFFECT OF COW CONDITION SCORE IN MAY ON BHB AND SUN LEVELS FOR COWS ON LOW LATE WINTER TREATMENT

	May condition score		
	2	3	4,5
No. cows	32	33	24
d-β-hydroxybutyrate, mg/dl	2.6^{a}	3.2^{ab}	4.0^{b}
Serum urea nitrogen, mg/dl	17.2	15.9	15.1

TABLE 6. EFFECT OF COW CONDITION SCORE IN MAY ON BHB AND SUN LEVELS FOR COWS ON HIGH LATE WINTER TREATMENT

	May condition score		
	2,3	4	5
No. cows	14	38	39
d-β-hydroxybutyrate, mg/dl	2.5	2.9	2.8
Serum urea nitrogen, mg/dl	17.6	16.2	17.2

In conclusion, a combination of BHB and SUN more accurately indicate cow nutritional status than either one individually. While these blood metabolites are useful in determining wide differences in nutritional status, they have limited value in consistently determining small differences due to large variation among cows of similar condition.